US009138878B2

(12) **United States Patent**
Ramm

(10) **Patent No.: US 9,138,878 B2**
(45) **Date of Patent: Sep. 22, 2015**

(54) **PISTON WIRE LOCK AND TOOL FOR INSERTING AND REMOVING THE SAME**

(76) Inventor: **Karl Ramm**, Lake Forest, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 883 days.

(21) Appl. No.: **13/376,574**

(22) PCT Filed: **Nov. 29, 2011**

(86) PCT No.: **PCT/US2011/062347**

§ 371 (c)(1),
(2), (4) Date: **Dec. 6, 2011**

(87) PCT Pub. No.: **WO2012/078401**

PCT Pub. Date: **Jun. 14, 2012**

(65) **Prior Publication Data**

US 2012/0174770 A1 Jul. 12, 2012

Related U.S. Application Data

(60) Provisional application No. 61/420,699, filed on Dec. 7, 2010.

(51) **Int. Cl.**
F16J 1/18 (2006.01)
B25B 27/20 (2006.01)

(52) **U.S. Cl.**
CPC ***B25B 27/20*** (2013.01); *Y10T 29/5363* (2015.01)

(58) **Field of Classification Search**
CPC B25B 27/20; F16J 1/18; Y10T 29/5363
USPC 92/128, 187, 189; 29/525, 222, 275, 29/278, 464, 468, 888.04, 888.05
See application file for complete search history.

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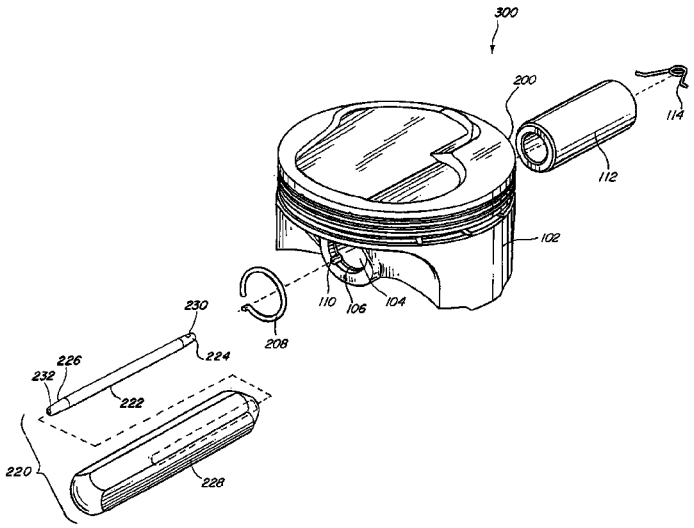
Primary Examiner — Dwayne J White
Assistant Examiner — Logan Kraft

(57) **ABSTRACT**

An anti-rotation wire lock for use in a piston to reduce rotation of the anti-rotation wire lock while seated inside a wrist pin lock groove of the piston. The anti-rotation wire lock includes a wire lock body which curls from a first end of the wire lock body and a second end which extends in a direction out of a plane defined by the curled wire lock body. In addition, wire lock tools are disclosed for inserting and removing the anti-rotation wire lock.

7 Claims, 12 Drawing Sheets



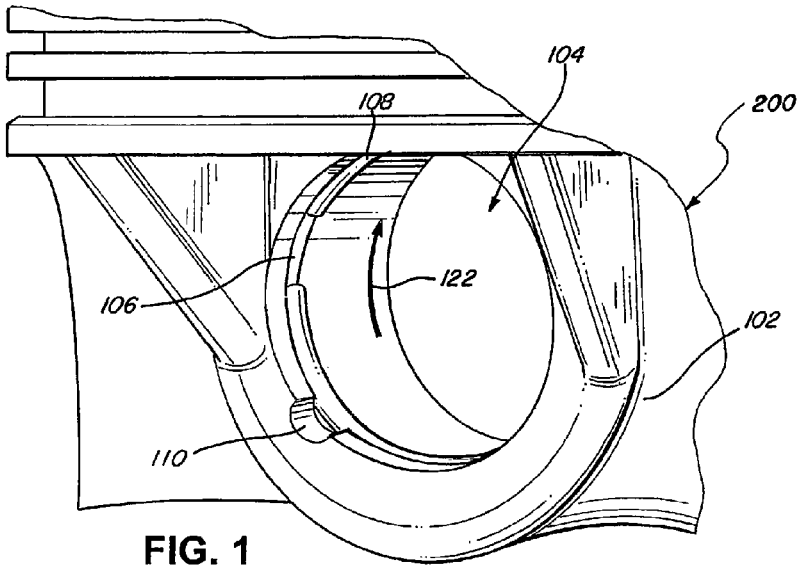


FIG. 1

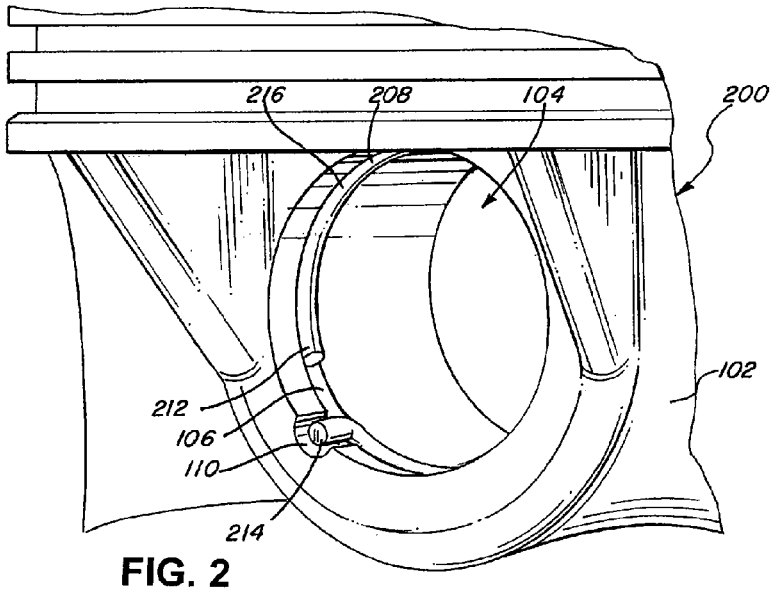


FIG. 2

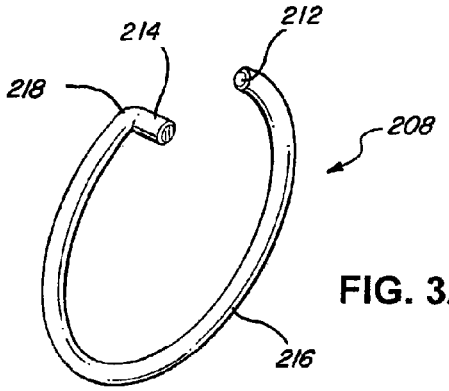


FIG. 3A

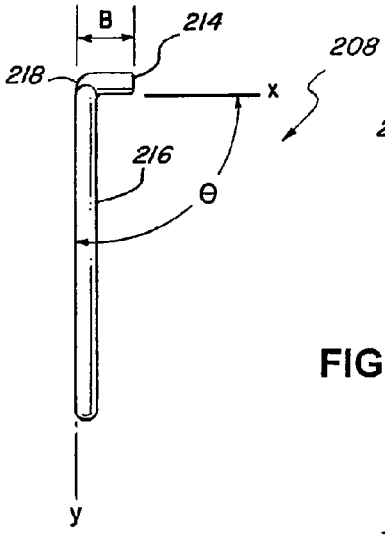


FIG. 3B

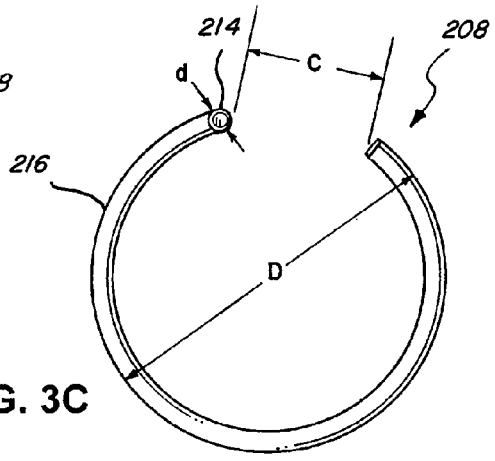


FIG. 3C

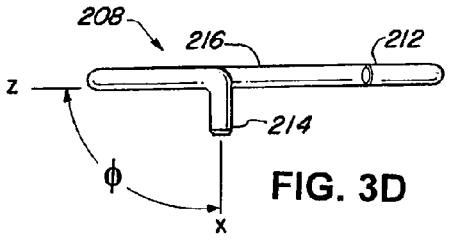


FIG. 3D

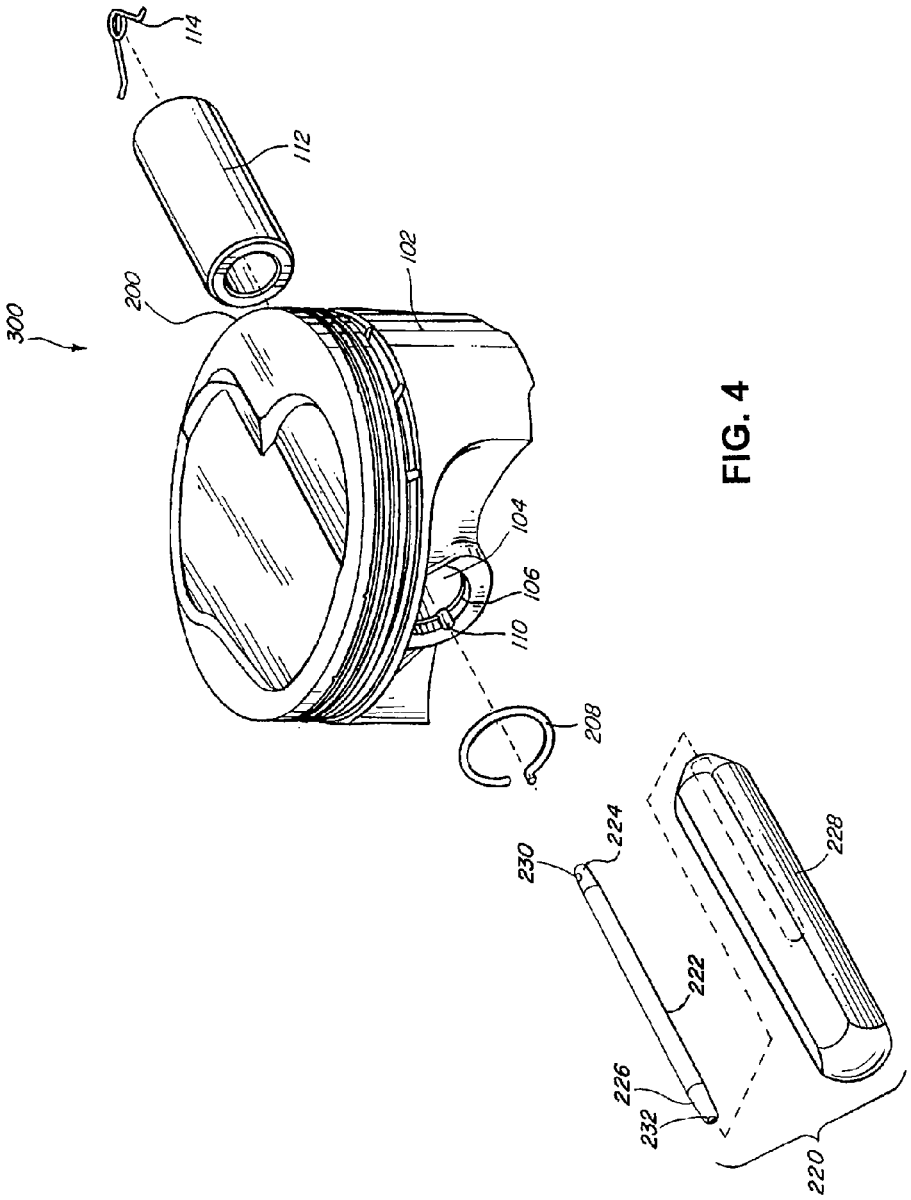


FIG. 4

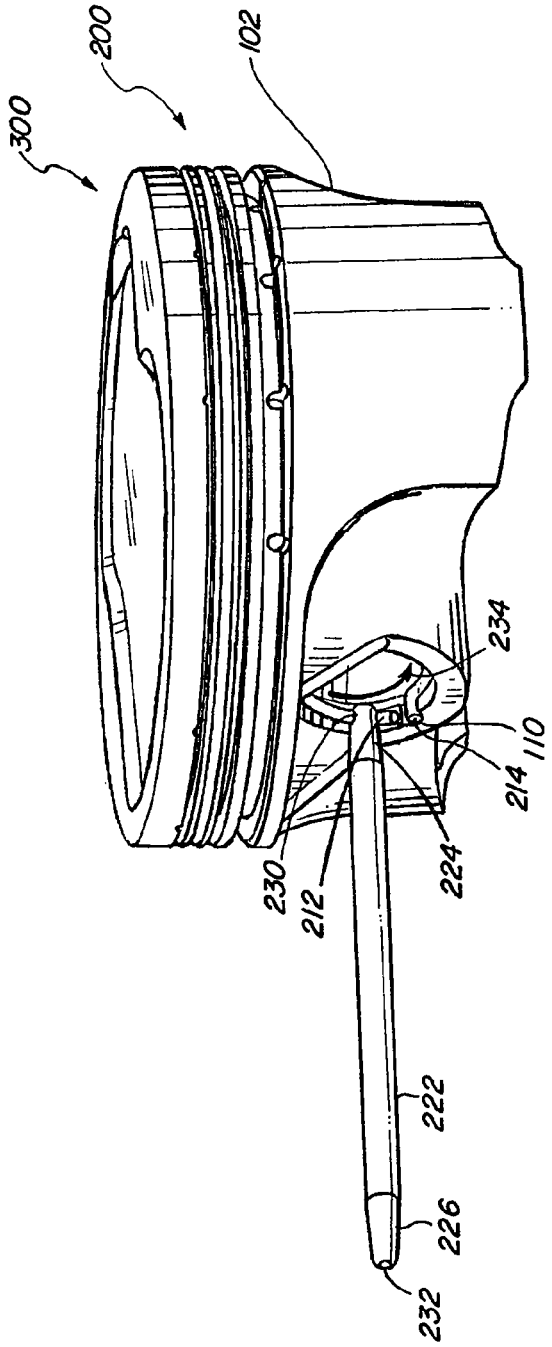


FIG. 5

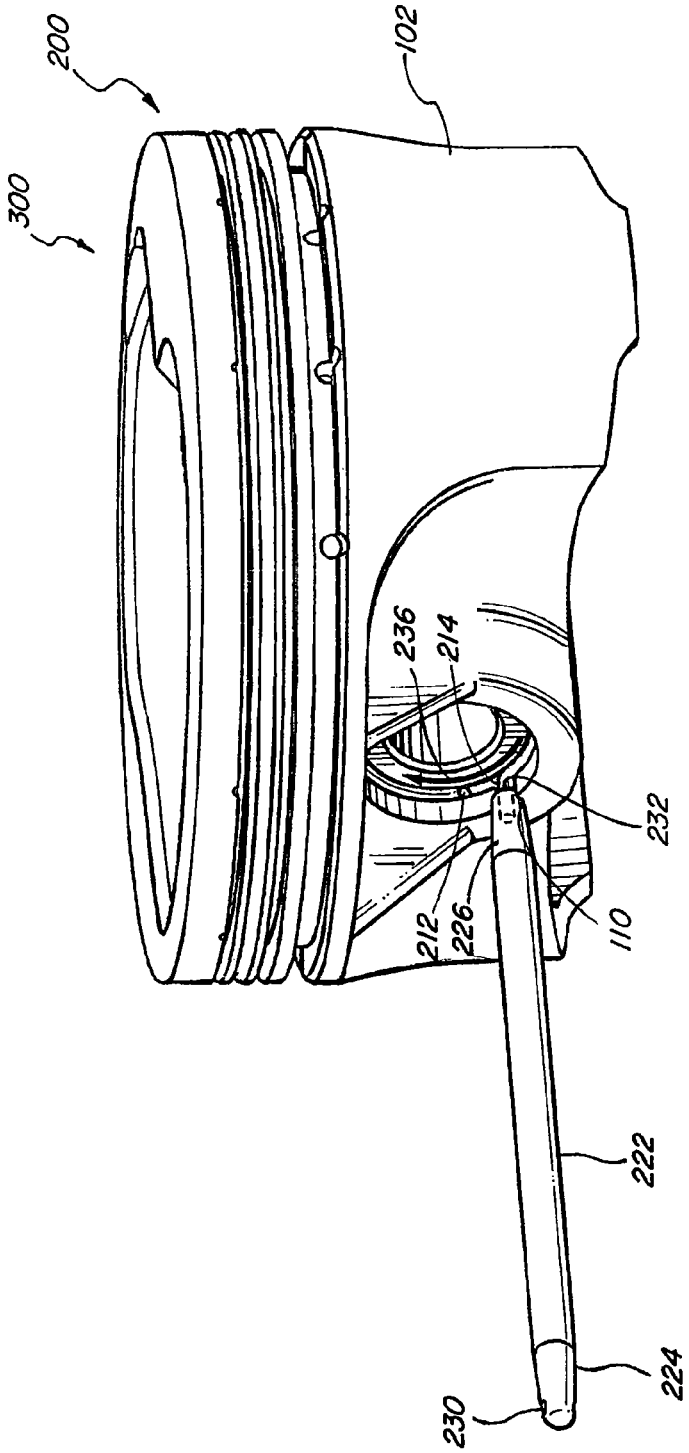


FIG. 6

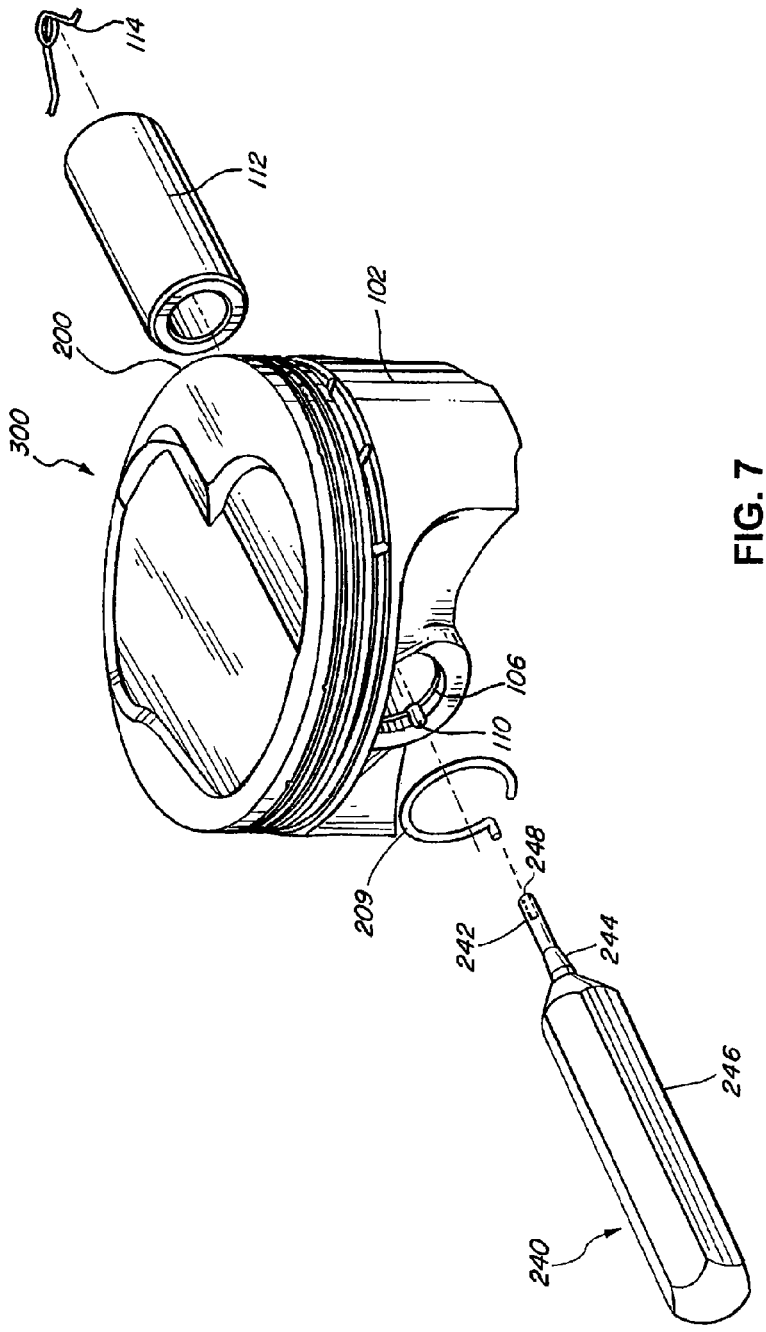


FIG. 7

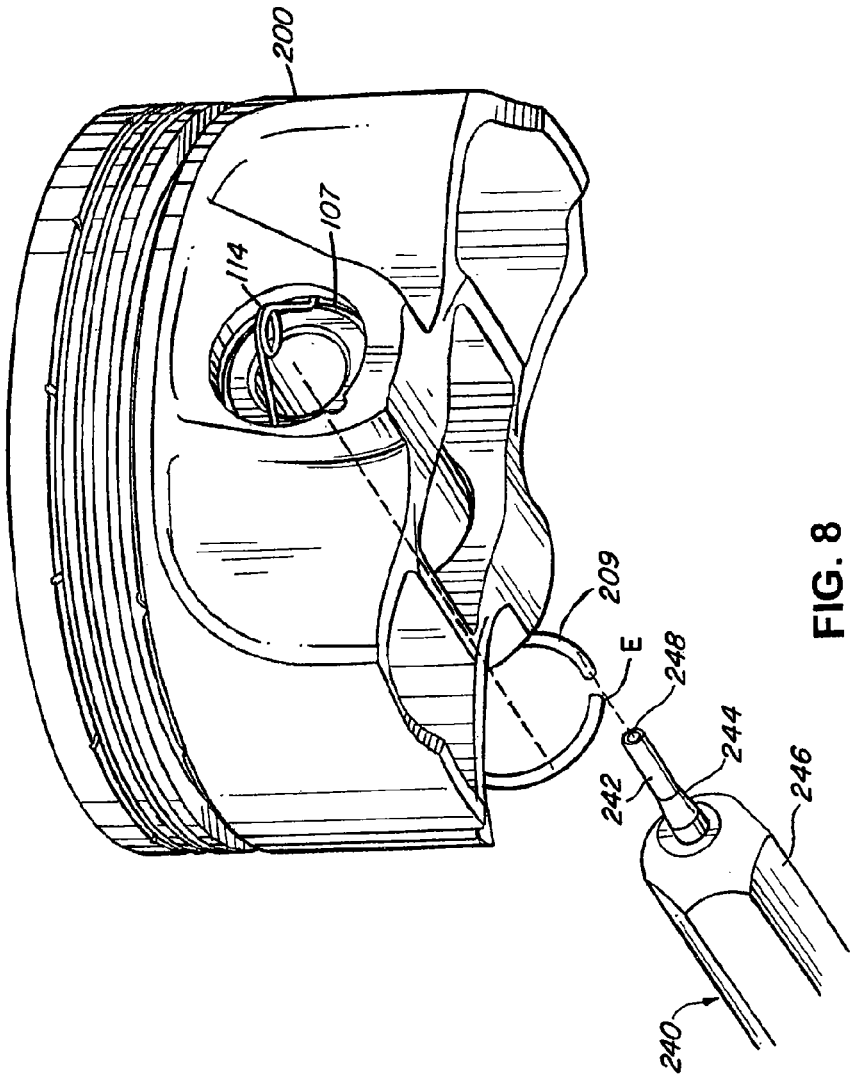


FIG. 8

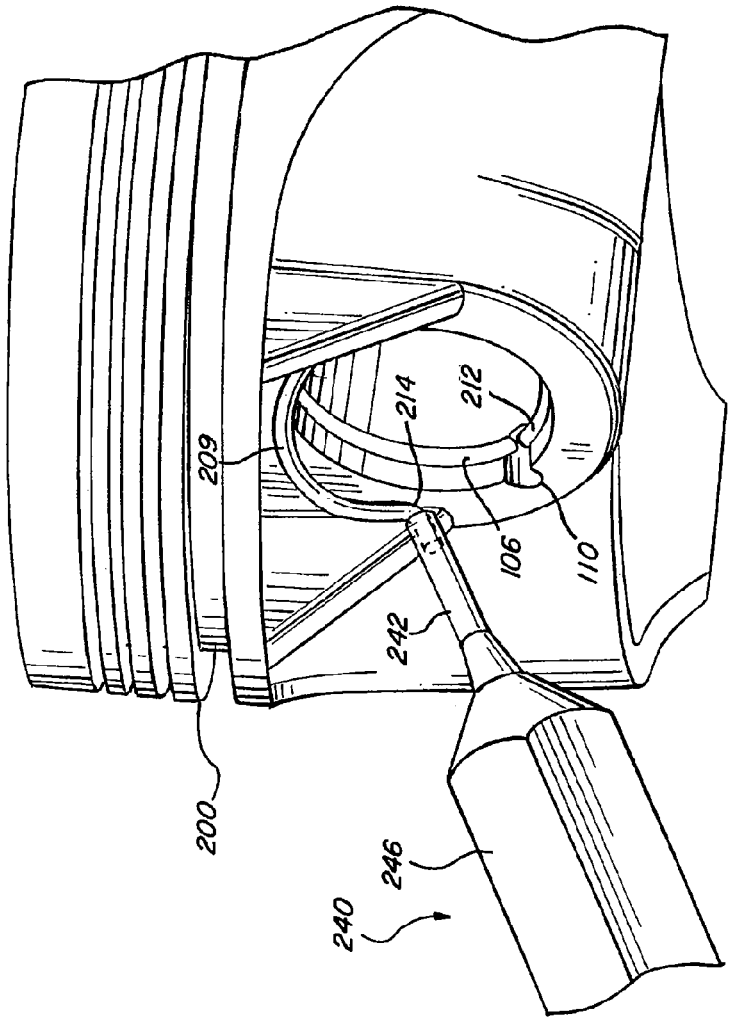


FIG. 9A

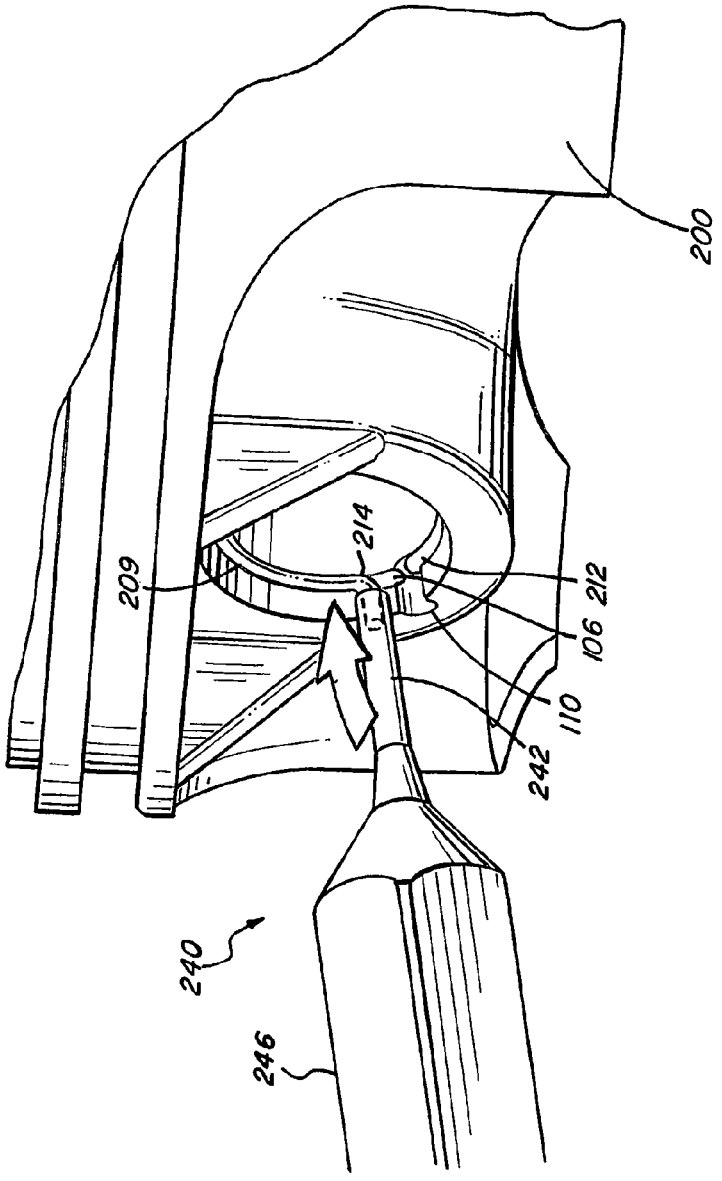


FIG. 9B

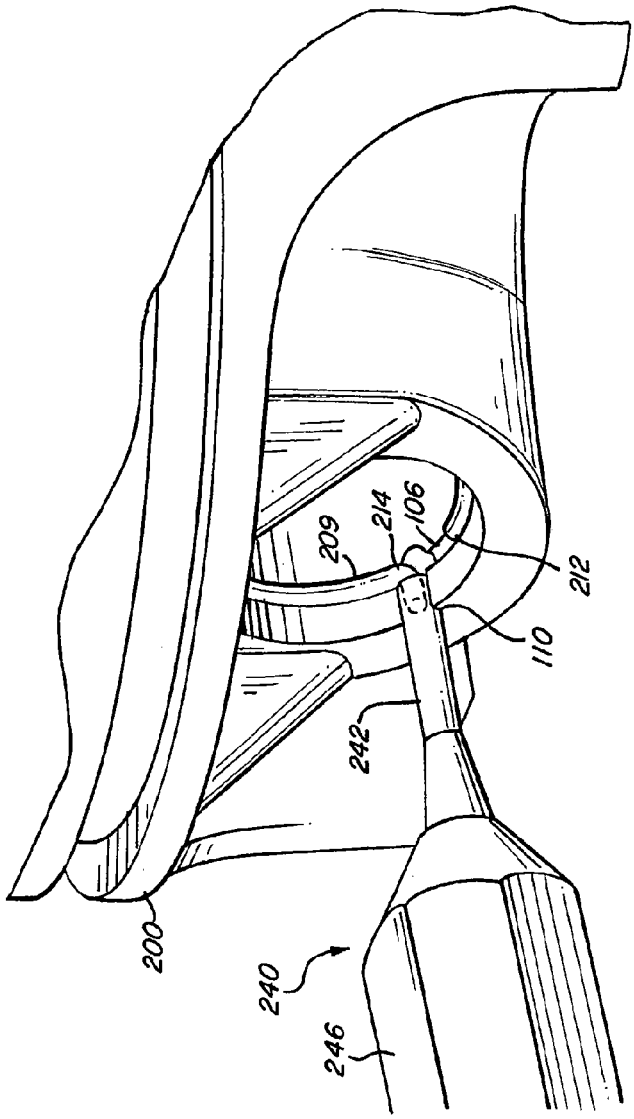


FIG. 9C

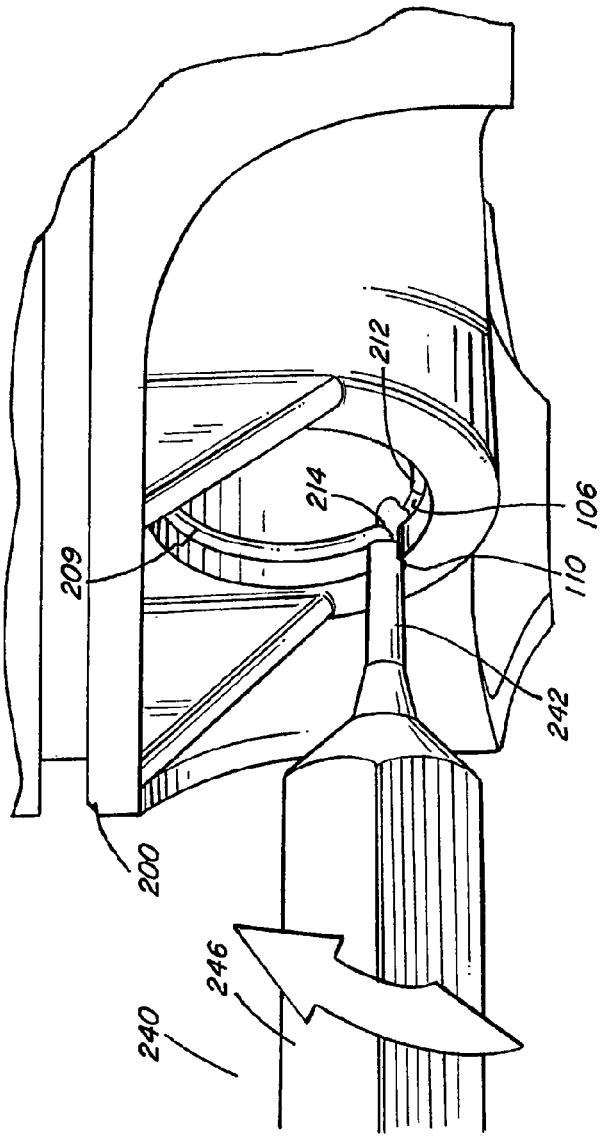


FIG. 10A

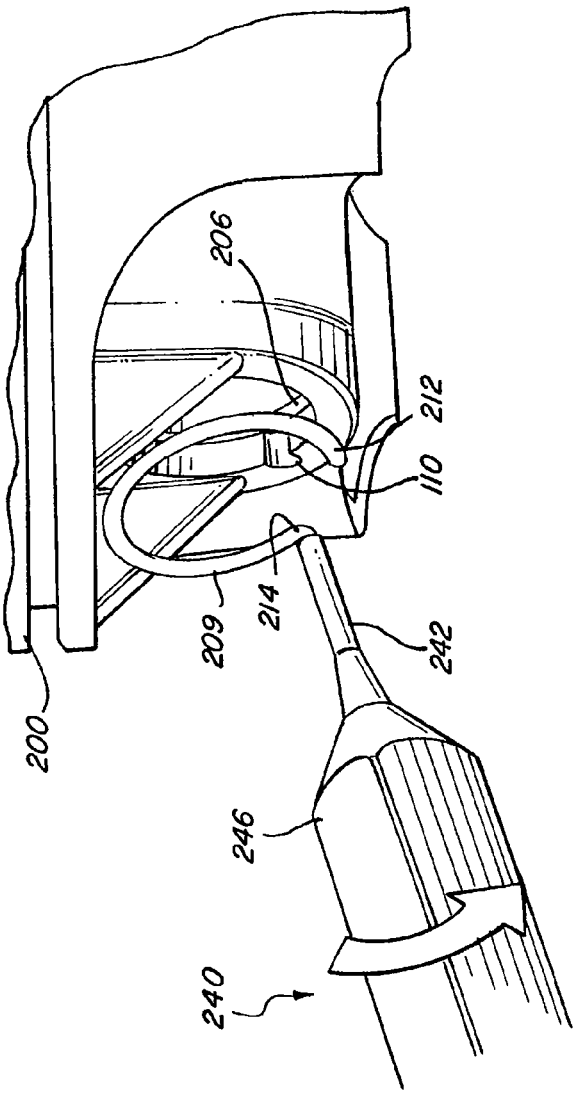


FIG. 10B

PISTON WIRE LOCK AND TOOL FOR INSERTING AND REMOVING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit and priority of U.S. Provisional Patent Application No. 61/420,699, filed on Dec. 7, 2010, entitled "Method and System for a Piston Anti-Rotating Wire Lock and Insertion and Removal of the Same," the entire contents of which are incorporated herein by reference.

FIELD

The present invention relates to a piston assembly in an internal combustion engine, compressor, or the like. More specifically, the present invention relates to a piston including an anti-rotation wire lock and a tool for inserting and removing the same.

BACKGROUND

Each year, consumers purchase motor vehicles, such as automobiles, motorcycles, boats and planes, from many different manufacturers. With each motor vehicle costing thousands of dollars, there is intense competition between manufacturers to produce motor vehicles which can run faster and are more reliable. However, when producing motor vehicles that run faster, inevitably, the engines must run at a faster rate. The increased operation of the engine translates into an increased operation of the piston and the components of the piston. More specifically, when moving the piston, a wrist pin is generally rotated and the more the piston moves, the greater the rate of rotation of the wrist pin. This is problematic in that the rotation of the wrist pins can also cause a conventional wire lock to rotate at an increased rate. The friction caused by the rotation of the conventional wire lock can deform the wrist pin lock groove where the conventional wire lock is secured. Deformation of the wrist pin lock groove can be catastrophic and can cause the wrist pin to malfunction and/or cause other problems. In some instances, the wrist pin may actually force its way out of the wrist pin lock groove. At high operations and rotations, a malfunction of the wrist pin can permanently or semi-permanently damage the piston.

Thus, conventional motor vehicles can have problems with reliability due to the rotation of the conventional wire lock and deformations caused by the rotation of the conventional wire lock. However, the conventional wire lock presents additional problems, too. When the conventional wire lock needs to be replaced, it is often difficult to retrieve them due to their propensity to rotate. Thus, users may use sharp objects in an attempt to pry the conventional wire lock away from the wrist pin lock groove. This can cause additional and sometimes severe damage to the piston.

While the damage caused by the conventional wire lock may appear to be minor or insignificant, any breach to the wrist pin lock groove can have catastrophic results to the piston and ultimately the engine. In such competitive motor vehicle markets, consumers will be unhappy with a motor vehicle which requires frequent engine repair or replacement.

Such problems can be further illustrated in FIG. **1**, which shows a piston **200** including a piston body **102** defining an aperture **104**. The aperture **104** is configured to receive a wrist pin (not shown). The piston body **102** also defines a wrist pin lock groove **106** for receiving a conventional wire lock **108**. In addition, the piston body **102** also defines a pick lock notch **110**. The pick lock notch **110** can be used to remove the conventional wire lock **108** from the wrist pin lock groove **106**.

Although the conventional wire lock **108** fits into the wrist pin lock groove **106** through tension, rotation of the wrist pin in a direction indicated by arrow **122**, for example, may cause the conventional wire lock **108** to rotate in the wrist pin lock groove **106**. As shown in FIG. **1**, there is no mechanical device to physically lock the conventional wire lock **108** into a substantially singular location. Thus, when a piston is reciprocating at high velocities and high rotations per minute, the wrist pin is also spinning at high rates. Since the wrist pin is located in the aperture **104**, it is in contact with the conventional wire lock **108**. This contact generally forces the conventional wire lock **108** to rotate within the wrist pin lock groove **106**. The rotation of the conventional wire lock **108** within the wrist pin lock groove **106** causes deformation of the wrist pin lock groove **106** and possibly even engine failure due to the wrist pin forcing its way beyond the conventional wire lock **108**. In addition, the conventional wire lock **108** can be rotated to a position such that the removal and replacement of the conventional wire lock **108** can be hazardous to the piston.

SUMMARY

The present application generally concerns an anti-rotation wire lock, a piston assembly including an anti-rotation wire lock, and tools for inserting and removing a wire lock. The anti-rotation wire lock of the present disclosure addresses the deformation concerns discussed above by ordinarily reducing the amount of wire lock rotation during operation of the piston. This allows the piston and the engine to function at a higher level without damaging the piston or the engine. As previously noted, such damage to the piston or the engine can cost the consumer a substantial amount of money to repair or replace the engine.

According to one embodiment, an anti-rotation wire lock includes a wire lock body which curls from a first end of the wire lock body and a second end which extends in a direction out of a plane formed by the curled wire lock body. With this configuration, it is ordinarily possible for the second end to fit into the pick lock notch and thereby reduce rotation of the anti-rotation wire lock in the wrist pin lock groove.

In addition, the foregoing configuration ordinarily facilitates insertion and removal of the anti-rotation wire lock with less rotation than for a conventional wire lock, thereby making insertion and removal of the anti-rotation wire lock easier. Thus, users who want to replace the anti-rotation wire lock can remove the anti-rotation wire lock in an easy manner with minimal contact to the wrist pin lock groove from sharp objects. This minimal contact further reduces the chances that the wrist pin lock groove will be damaged.

To further simplify the removal process and to further protect the wrist pin lock groove, the present disclosure also includes embodiments of a wire lock tool for insertion and removal of a wire lock. According to one embodiment, a wire lock tool includes a shaft having an insertion end defining a through hole constructed to mate with a first end of a wire lock and a removal end on a side opposite the insertion end and defining a blind hole constructed to mate with a bent end of the wire lock.

According to another embodiment of a wire lock tool, the wire lock tool includes a shaft and a handle connected to the shaft on one end of the shaft. The shaft includes a blind hole

on an end portion of the shaft opposite the handle and the blind hole is constructed to mate with a bent end of a wire lock.

The use of the foregoing wire lock tools for inserting and removing a wire lock ordinarily reduces the need to use sharp tools which may damage the wrist pin lock groove. Furthermore, the foregoing wire lock tools can also facilitate the easy insertion and removal of the anti-rotation wire lock, which can reduce time spent replacing a wire lock. This can also further increase cost savings associated with the use of the anti-rotation wire lock.

Such advantages provided by the anti-rotation wire lock and tools of the present disclosure can improve the reliability of motor vehicles produced by manufacturers, and in some instances, allow manufacturers to increase the performance of the motor vehicle. Furthermore, the use of the anti-rotation wire lock and tools of the present disclosure can increase confidence in consumers purchasing motor vehicles, resulting in higher sales.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the present embodiments will become more apparent from the detailed description set forth below when taken in conjunction with the drawings. The drawings and the associated descriptions are provided to illustrate embodiments of the invention and not to limit the scope of the invention. Reference numbers are reused throughout the drawings to indicate correspondence between referenced elements.

FIG. **1** illustrates a close up view of a piston assembly including a conventional wire lock.

FIG. **2** illustrates a close-up view of a piston assembly including an anti-rotation wire lock according to an embodiment of the present invention.

FIG. **3**A illustrates a perspective view of an anti-rotation wire lock according to an embodiment of the present invention.

FIG. **3**B illustrates a side view of an anti-rotation wire lock according to an embodiment of the present invention.

FIG. **3**C illustrates a front view of an anti-rotation wire lock according to an embodiment of the present invention.

FIG. **3**D illustrates a top view of an anti-rotation wire lock according to an embodiment of the present invention.

FIG. **4** illustrates an exploded view of a piston assembly with a first embodiment of a wire lock tool for inserting and removing a wire lock.

FIG. **5** illustrates insertion of a wire lock using the wire lock tool of the first embodiment.

FIG. **6** illustrates removal of a wire lock using the wire lock tool of the first embodiment.

FIG. **7** illustrates an exploded view of a piston assembly with second embodiment of a wire lock tool for inserting and removing a wire lock.

FIG. **8** illustrates a rear perspective view of insertion of a wire lock using the wire lock tool of the second embodiment.

FIG. **9**A illustrates an initial positioning of a wire lock during insertion of the wire lock with the wire lock tool of the second embodiment.

FIG. **9**B illustrates subsequent positioning of the wire lock of FIG. **9**A during insertion of the wire lock using the wire lock tool of the second embodiment.

FIG. **9**C illustrates a final positioning of the wire lock of FIGS. **9**A and **9**B during insertion of the wire lock using the wire lock tool of the second embodiment.

FIG. **10**A illustrates an initial positioning of a wire lock during removal of the wire lock using the wire lock tool of the second embodiment.

FIG. **10**B illustrates a final positioning of a wire lock during removal of the wire lock of FIG. **10**A using the wire lock tool of the second embodiment.

DETAILED DESCRIPTION

In the following detailed description, numerous specific details are set forth to provide a full understanding of the present invention. It will be apparent, however, to one ordinarily skilled in the art that the present invention may be practiced without some of these specific details. In other instances, well-known structures and techniques have not been shown in detail to avoid unnecessarily obscuring the present invention.

FIG. **2** illustrates a close-up view of a piston including an anti-rotation wire lock according to an embodiment of the present invention. The piston **200** includes a piston body **102** defining an aperture **104**. The aperture **104** is configured to receive a wrist pin (such as wrist pin **112** in FIG. **4**). The piston body **102** also defines a wrist pin lock groove **106** for receiving an anti-rotation wire lock **208**. In addition, the piston body **102** also defines a pick lock notch **110**. Both the wrist pin lock groove **106** and/or the pick lock notch **110** are part of the aperture **104**. The pick lock notch **110** can be used to remove the anti-rotation wire lock **208** from the wrist pin lock groove **106**.

As shown in FIG. **2**, the wire lock body **216** of the anti-rotation wire lock **208** is configured to be placed into the wrist pin lock groove **106**. Such placement may be accomplished through tension of the wire lock body **216**, which is generally in a "C" shape. Second end **214** is configured to be placed into the pick lock notch **110**, thereby reducing rotation of the wire lock body **216** even when the wrist pin rotates in the aperture **104**.

In one embodiment, the anti-rotation wire lock **208** can be formed, for example, from chrome silicon and can have, for example, a finish of black oxide. However, the anti-rotation wire lock **208** can also be formed from other materials and have other finishes that are suitable for use in a piston. Also, the anti-rotation wire lock **208** can have a hardness of RC 52-54. However, the anti-rotation wire lock **208** can have any hardness which would render it suitable for use in a piston. In one embodiment, the ends of the anti-rotation wire lock **208** are deburred. In yet another embodiment, the entire anti-rotation wire lock can be deburred.

FIG. **3**A illustrates a perspective view of the anti-rotation wire lock **208** according to an example embodiment. As shown in FIG. **3**A, the wire lock body **216** curls from the first end **212** toward a bend **218**. The second end **214** is connected to the wire lock body **216** by the bend **218** and extends in a direction out of a plane defined by the wire lock body **216**.

This relationship is further illustrated in FIG. **3**B, which depicts a side view of the anti-rotation wire lock **208**. In particular, the second end **214** extends along a plane x that is out of a plane y defined by the wire lock body **216**. In the embodiment of FIG. **3**B, the second end **214** extends in a direction substantially perpendicular to plane y. Accordingly, in this example embodiment, angle θ in FIG. **3**B is approximately 90 degrees. In addition, the second end **214** extends from the wire lock body **216** along plane x by a distance B. In one example embodiment, the distance B can be within a range of 0.10 to 0.16 inches. However, it is understood that the second end **214** can protrude from the anti-rotation wire lock

body **216** by any other suitable length so that the anti-rotation wire lock **208** can rest in the pick lock notch **110**.

FIG. **3**C illustrates a front view of the anti-rotation wire lock **208** depicting a diameter D and opening C of the wire lock body **216**. As will be appreciated by those of ordinary skill in the art, diameter D and opening C vary based upon the dimensions of the wrist pin lock groove in which the anti-rotation wire lock **208** is to rest. Similarly, diameter d of second end **214** varies based upon the dimensions of the pick lock notch in which the anti-rotation wire lock **208** is to rest. In one example embodiment, for example, the diameter d can be within a range of 0.0615 to 0.0635 inches. In yet another embodiment, diameter d can be within a range of 0.935 to 0.955 inches.

Although the second end **214** is on the left side of the opening C in FIG. **3**C, it is understood that in other embodiments, the second end **214** and the first end **212** can be switched such that the second end **214** appears on the right side of opening C. This concept can be better understood by comparing the anti-rotation wire lock **208** of FIGS. **2** to **6** with the anti-rotation wire lock **209** of FIGS. **7** to **10**.

As shown in the top view of FIG. **3**D, the second end **214** defines an angle ϕ between plane x and a plane z, which is horizontal to the top surface of the wire lock body **216**. In this example embodiment, angle ϕ is approximately 90 degrees, however, angle ϕ can vary without departing from the spirit and scope of the present invention. For example, in one embodiment, angle ϕ can be within a range of 60 degrees to 130 degrees and still rest in the pick lock notch **110** to provide rotational resistance. In other embodiments, the second end **214** can curl or have a circular shape while being able to fit into the pick lock notch **110** and provide rotational resistance.

By reducing the rotation of the anti-rotation wire lock **208**, the wear and tear of the wrist pin lock groove **106** is substantially reduced or eliminated. This can ordinarily increase the longevity of the piston **200** and in some instances, allow for the piston **200** to operate at higher levels resulting in greater performance. In addition, the orientation of second end **214** to wire lock body **216** also facilitates easy insertion and removal of the anti-rotation wire lock **208**, as discussed below.

FIG. **4** illustrates an exploded view of a piston assembly **300** when inserting the anti-rotation wire lock **208** into the wrist pin lock groove **106** of piston body **102**. Before inserting the anti-rotation wire lock **208**, the wrist pin **112** is inserted into the aperture **104**. The wrist pin **112** is temporarily held in aperture **104** using a clip **114** that fits into a wrist pin lock groove **107** on the opposite side of the anti-rotation wire lock **208**, as shown in FIG. **8**.

In FIG. **4**, the anti-rotation wire lock **208** is inserted using a first embodiment of a wire lock tool. As shown in FIG. **4**, wire lock tool **220** includes a shaft **222** having an insertion end **224** and a removal end **226**. The insertion end **224** can be used, for example, to insert the anti-rotation wire lock **208**, while the removal end **226** can be used, for example, to remove the anti-rotation wire lock **208**. Both the insertion end **224** and the removal end **226** have an outside surface that is tapered so as to provide easier access and movement of the anti-rotation wire lock **208** when it is positioned in the wrist pin lock groove. In addition, both the insertion end **224** and the removal end **226** of the present embodiment are rounded at their ends to further reduce the likelihood of scratching piston **200**.

Wire lock tool **220** optionally includes a removable handle **228** which is constructed to fit onto the removal end **226** and a middle portion of the shaft **222** when the wire lock tool **220** is in a configuration for inserting the anti-rotation wire lock **208**. Similarly, the handle **228** is also constructed to fit onto the insertion end **224** and a middle portion of the shaft **222** when the wire lock tool **220** is in a configuration for removing the anti-rotation wire lock **208**.

As shown in FIG. **4**, the insertion end **224** defines a through hole **230** which is constructed to mate with the first end **212** of the anti-rotation wire lock **208**. In the embodiment of FIG. **4**, the through hole **230** is substantially perpendicular to a longitudinal axis defined by the shaft **222**. Opposite the insertion end **224**, the removal end **226** defines a blind hole **232** which is constructed to mate with the second end **214** of the anti-rotation wire lock **208**. In this regard, the blind hole **232** of the present embodiment is substantially parallel to a longitudinal axis defined by the shaft **222**.

FIG. **5** illustrates insertion of the anti-rotation wire lock **208** using the wire lock tool **220** without the removable handle **228** attached to the shaft **222**. As shown in FIG. **5**, to insert the anti-rotation wire lock **208**, the second end **214** of the anti-rotation wire lock **208** is placed in the pick lock notch **110**. The first end **212** is then secured in through hole **230** of the wire lock tool **220**. By rotating the first end **212** in a direction **234** towards the second end **214**, the anti-rotation wire lock **208** can be semi-deformed, temporarily reducing the diameter of the anti-rotation wire lock **208**. This temporary deformation of the anti-rotation wire lock **208** results from the rotational resistance provided by the second end **214** when resting in the pick lock notch **110**. The anti-rotation wire lock **208** can then be slipped into the wrist pin lock groove **106**. Once the anti-rotation wire lock **208** is substantially in the wrist pin lock groove **106**, the first end **212** can be rotated in an opposite direction of the direction **234** to increase the diameter of the anti-rotation wire lock **208** and allow for removal of the first end **212** from through hole **230**.

FIG. **6** illustrates removal of the anti-rotation wire lock **208** using the wire lock tool **220** without the removable handle **228** attached to the shaft **222**. As shown in FIG. **6**, to remove the anti-rotation wire lock **208**, the shaft **222** of wire lock tool **220** is placed such that the second end **214** of the anti-rotation wire lock **208** is secured in blind hole **232**. In this configuration, the second end **214** of anti-rotation wire lock **208** provides leverage for removing the anti-rotation wire lock **208** from the wrist pin lock groove **106**. By rotating the second end **214** in a direction **236** towards the first end **212**, the anti-rotation wire lock **208** can be semi-deformed, temporarily reducing the diameter of the anti-rotation wire lock **208**. The anti-rotation wire lock **208** can then be slipped out of the wrist pin lock groove **106** and removed. Once the anti-rotation wire lock **208** is substantially out of the wrist pin lock groove **106**, the diameter of the anti-rotation wire lock **208** will ordinarily increase as it returns to its normal shape.

As will be appreciated by those of ordinary skill in the art, the directions **234** and **236** for insertion and removal are merely opposite directions from each other. For example, if direction **236** is clockwise, then direction **234** is counter-clockwise, and vice-versa. The respective directions for insertion and removal depend upon the sides of opening C (shown in FIG. **3**C) that are chosen for the second end **214** and the first end **212**. This can be better understood by comparing the anti-rotation wire lock **208** of FIG. **4** with the anti-rotation wire lock **209** of FIG. **7**.

FIG. **7** illustrates an exploded view of piston assembly **300** when inserting an anti-rotation wire lock **209** into the wrist pin lock groove **106** of piston body **102**. As with FIG. **4**, before inserting the anti-rotation wire lock **209**, the wrist pin **112** is inserted into the aperture **104**. The wrist pin **112** is temporarily held in aperture **104** using a clip **114** that fits into a wrist pin lock groove **107** on the opposite side of the anti-rotation wire lock **209**, as shown in FIG. **8**.

In FIG. **7**, the anti-rotation wire lock **209** is inserted using a second embodiment of a wire lock tool. As shown in FIG. **7**, wire lock tool **240** includes a shaft **242** and a handle **246**. The shaft **242** includes a taper **244** for added strength and a blind hole **248** for mating with the second end **214** of the anti-rotation wire lock **209**. The blind hole **248** is substantially parallel to an axis defined by the shaft **242**. In addition, the shaft **242** can have a rounded end near the blind hole **240** to further reduce the likelihood of scratching the piston **200**.

FIG. **8** illustrates a rear perspective view of insertion of the anti-rotation wire lock **209** using the wire lock tool **240**. As shown in FIG. **8**, clip **114** is temporarily inserted into the wrist pin lock groove **107** after the wrist pin has been inserted into aperture **104**. In this configuration, the wrist pin is ordinarily prevented from sliding out of aperture **104** while the anti-rotation wire lock **209** is inserted on the opposite side of the piston **102**. After the first anti-rotation wire lock is completely inserted, clip **114** can be removed for insertion of a second anti-rotation wire lock into wrist pin lock groove **107**.

FIG. **9**A depicts an initial positioning of anti-rotation wire lock **209** during insertion with wire lock tool **240**. The first end **212** of the anti-rotation wire lock **209** is placed in the wrist pin lock groove **106** close to, if not in, pick lock notch **110**. The shaft **242** of wire lock tool **240** is placed such that the second end **214** of the anti-rotation wire lock is secured in blind hole **248**.

As shown in FIG. **9**B, the anti-rotation wire lock **209** is then compressed towards the center of aperture **104** until the anti-rotation wire lock **209** slides into the wrist pin lock groove **106**. If the second end **214** of the anti-rotation wire lock **209** is not already resting in pick lock notch **110**, the anti-rotation wire lock **209** is rotated towards pick lock notch **110** until the second end **214** is positioned in pick lock notch **110**, as shown in FIG. **9**C. In the present embodiment, and as seen in FIGS. **9**C and **10**A, the end portion of shaft **242** fits into pick lock notch **110** for easy insertion and removal.

FIGS. **10**A and **10**B illustrate removal of the anti-rotation wire lock **209** from the wrist pin lock groove **106** using wire lock tool **240**. In FIG. **10**A, an end portion of shaft **242** is placed in pick lock notch **110** such that the second end **214** of the anti-rotation wire lock **209** is secured in blind hole **248** of the wire lock tool **240**. The handle **246** of the wire lock tool **240** is then moved in the general direction indicated by the arrow in FIG. **10**A to pop the anti-rotation wire lock **209** out of the wrist pin lock groove **106**. In this sense, the second end **214** of anti-rotation wire lock **209** provides leverage for removing the anti-rotation wire lock **209** from the wrist pin lock groove **106**.

The handle **246** is then rotated in the general direction indicated by the arrow in FIG. **10**B. As a result, the second end **214** of the anti-rotation wire lock **209** is rotated in a direction towards the first end **212** and the anti-rotation wire lock **209** is semi-deformed, temporarily reducing the diameter of the anti-rotation wire lock **209**. The anti-rotation wire lock **209** can then be slipped out of the wrist pin lock groove **106** and removed. Once the anti-rotation wire lock **209** is substantially out of the wrist pin lock groove **106**, the diameter of the anti-rotation wire lock **209** will ordinarily increase as it returns to its normal shape.

Thus, the above described use of wire lock tools in combination with the anti-rotation wire locks of the present disclosure allows for an easy insertion and an easy removal of an anti-rotation wire lock. This can ordinarily prevent damage to piston **200**, and more specifically, to the wrist pin lock groove **106**.

The terms "a," "an," "the" and similar referents used in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. Recitation of ranges of values herein is merely intended to serve as a shorthand method of referring individually to each separate value falling within the range. Unless otherwise indicated herein, each individual value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention otherwise claimed. No language in the specification should be construed as indicating any non-claimed element essential to the practice of the invention.

Groupings of alternative elements or embodiments of the invention disclosed herein are not to be construed as limitations. Each group member may be referred to and claimed individually or in any combination with other members of the group or other elements found herein. It is anticipated that one or more members of a group may be included in, or deleted from, a group for reasons of convenience and/or patentability. When any such inclusion or deletion occurs, the specification is deemed to contain the group as modified thus fulfilling the written description of any Markush groups used in the appended claims.

Certain embodiments of this invention are described herein, including the best mode known to the inventor for carrying out the invention. Of course, variations on these described embodiments will become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventor expects skilled artisans to employ such variations as appropriate, and the inventor intends for the invention to be practiced otherwise than specifically described herein. Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context.

In closing, it is to be understood that the embodiments of the invention disclosed herein are illustrative of the principles of the present invention. Other modifications that may be employed are within the scope of the invention. Thus, by way of example, but not of limitation, alternative configurations of the present invention may be utilized in accordance with the teachings herein. Accordingly, the present invention is not limited to that precisely as shown and described.

What is claimed is:

1. A wire lock tool for inserting a wire lock into a wrist pin lock groove of a piston and for removing the wire lock from the wrist pin lock groove of the piston, wherein the wire lock includes a first end and a bent end, the wire lock tool comprising:

a shaft including an insertion end defining a through hole constructed to mate with the first end of the wire lock, and a removal end on a side opposite the insertion end and defining a blind hole constructed to mate with the bent end of the wire lock.

2. The wire lock tool of claim **1**, wherein the blind hole of the removal end is substantially parallel to an axis defined by the shaft.

3. The wire lock tool of claim **1**, wherein the through hole of the insertion end is substantially perpendicular to an axis defined by the shaft.

4. The wire lock tool of claim 1, wherein the removal end fits into a pick lock notch of the piston.

5. The wire lock tool of claim 1, wherein at least a portion of the removal end tapers on an outside surface.

6. The wire lock tool of claim 1, wherein an outside surface of the removal end is rounded near the blind hole.

7. The wire lock tool of claim 1, further comprising a removable handle, wherein the removable handle is constructed to fit onto the insertion end and a middle portion of the shaft when the wire lock tool is in a configuration for removing the wire lock, and wherein the removable handle is constructed to fit onto the removal end and a middle portion of the shaft when the wire lock tool is in a configuration for inserting the wire lock.

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